CLAIMS LISTING

1. (currently amended) A method for optimizing a wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set of nodes further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

an antennae array of ~~M~~ *M* antennae, where ~~M~~ *M* ≥ one,

a transceiver for each antenna in said spatially diverse antennae array,

means for digital signal processing to convert analog radio signals into digital signals and digital signals into analog radio signals,

means for coding and decoding data, symbols, and control information into and from digital signals,

diversity capability means for transmission and reception of said analog radio ~~waves~~ signals,

and,

means for input and output from and to a non-radio interface for digital signals;

said set of nodes being deployed according to design rules that prefer meeting the following criteria:

said set of nodes further comprising two or more proper subsets of nodes, with a first proper subset being the transmit uplink / receive downlink set, and a second proper subset being the transmit downlink / receive uplink set;

each node in said set of nodes belonging to no more transmitting uplink or receiving uplink subsets than it has diversity capability means;

each node in a transmit uplink / receive downlink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability means;

each node in a transmit downlink / receive uplink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability means;

each member of a transmit uplink / receive downlink subset cannot hold time and frequency coincident communications with any other member of that transmit uplink / receive downlink subset;

and,

each member of a transmit downlink / receive uplink subset cannot hold time and frequency coincident communications with any other member of that transmit downlink / receive uplink subset;

transmitting, in said wireless electromagnetic communications network, independent information from each node belonging to a first proper subset, to one or more receiving nodes belonging to a second proper subset that are viewable from the transmitting node;

processing independently, in said wireless electromagnetic communications network, at each receiving node belonging to said second proper subset, information transmitted from one or more nodes belonging to said first proper subset;

and,

dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network.

2. (currently amended) A method for optimizing a wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set of nodes further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

a spatially diverse antennae array of ~~M~~ $\underline{M}$ antennae, where ~~M~~ $\underline{M} \geq$ two,

a transceiver for each antenna in said spatially diverse antennae array,

means for digital signal processing to convert analog radio signals into digital signals and digital signals into analog radio signals,

means for coding and decoding data, symbols, and control information into and from digital signals,

diversity capability means for transmission and reception of said analog radio ~~waves~~ <u>signals</u>,

and,

means for input and output from and to a non-radio interface for digital signals;

said set of nodes being deployed according to design rules that prefer meeting the following criteria:

said set of nodes further comprising two or more proper subsets of nodes, with a first proper subset being the transmit uplink / receive downlink set, and a second proper subset being the transmit downlink / receive uplink set;

each node in said set of nodes belonging to no more transmitting uplink or receiving uplink subsets than it has diversity capability means;

each node in a transmit uplink / receive downlink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability <u>means;</u>

each node in a transmit downlink / receive uplink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability means;

each member of a transmit uplink / receive downlink subset cannot hold time and frequency coincident communications with any other member of that transmit uplink / receive downlink subset;

and,

each member of a transmit downlink / receive uplink subset cannot hold time and frequency coincident communications with any other member of that transmit downlink / receive uplink subset;

transmitting, in said wireless electromagnetic communications network, independent information from each node belonging to a first proper subset, to one or more receiving nodes belonging to a second proper subset that are viewable from the transmitting node;

processing independently, in said wireless electromagnetic communications network, at each receiving node belonging to said second proper subset, information transmitted from one or more nodes belonging to said first proper subset;

and,

dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network.

3. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

using substantive null steering to minimize SINR between nodes transmitting and receiving information.

4. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

using max-SINR null- and beam-steering to minimize intra-network interference.

5. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

using MMSE null- and beam-steering to minimize intra-network interference.

6. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

designing the network such that reciprocal symmetry exists for each pairing of uplink receive and downlink receive proper subsets.

7. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

designing the network such that substantial reciprocal symmetry exists for each pairing of uplink receive and downlink receive proper subsets.

8. (original) A method as in claim 1, wherein the network uses TDD communication protocols.

9. (original) A method as in claim 1, wherein the network uses FDD communication protocols.

10. (original) A method as in claim 3, wherein the network uses simplex communication protocols.

11. (original) A method as in claim 1, wherein the network uses random access packets, and receive and transmit operations are all carried out on the same frequency channels for each link.

12. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises

if the received interference is spatially white in both link directions, setting

~~$g_1(aq)\ \alpha\ w^*{}_2 q$ and $g_2(q)\ \alpha\ w^*{}_1(q)$~~

$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$ at both ends of the link,

where ~~$\{g_2(q), w_1(q)\}$~~

$\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining ~~$\{g_1(q)\}$ and $\{g_2(q)\}$~~ $\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$ to preferentially satisfy:

$$\cancel{\sum_{q=1}^{Q_{21}} g^T{}_1(q) R_{i1i1}[n_1(q)] g^*{}_1(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\{R_{i1,i1}(n)\} = M_1 R_1}$$

$$\cancel{\sum_{q=1}^{Q_{12}} g^{T}{}_{2}(q) R_{i2i2}[n_2(q)] g^{*}{}_{2}(q) = \sum_{n=1}^{N_2} \mathrm{Tr}\{R_{i2i2}(n)\} = M_2R_2.}$$

$$\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q)\mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}\left(n_1(q)\right)\mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}(n)\right\} = M_1R_1$$

$$\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q)\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}\left(n_2(q)\right)\mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}(n)\right\} = M_2R_2 \quad .$$

13. (currently amended) A method as in claim 1, wherein:

a proper subset may incorporate one or more nodes that are in a receive-only mode for every diversity ~~channel~~ capability means.

14. (original) A method as in claim 1, wherein:

the network may dynamically reassign a node from one proper subset to another.

15. (original) A method as in claim 1, wherein:

the network may dynamically reassign a proper subset of nodes from one proper subset to another.

16. (currently amended) A method as in claim 7, wherein the step of designing the network such that substantial reciprocal symmetry exists for the uplink and downlink channels further comprises:

if the received interference is spatially white in both link directions, setting

$\cancel{g_1(aq) \alpha w^*{}_2 q}$ ~~and~~ $\cancel{g_2(q) \alpha w^*{}_1(q)}$

$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $g_1(q) \propto \mathbf{w}_1^*(q)$ at both ends of the link, where $\cancel{\{g_2(q), w_1(q)\}}$ $\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining $\cancel{\{g_1(q)\}}$ ~~and~~ $\cancel{\{g_2(q)\}}$ $\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$ to preferentially satisfy:

$$\cancel{\sum_{q=1}^{Q_{21}} g^T{}_1(q) R_{i1i1}[n_1(q)] g^*{}_1(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\{R_{i1i1}(n)\} = M_1 R_1}$$

$$\cancel{\sum_{q=1}^{Q_{12}} g^T{}_2(q) R_{i2i2}[n_2(q)] g^*{}_2(q) = \sum_{n=1}^{N_2} \mathrm{Tr}\{R_{i2i2}\square(n)\} = M_2 R_2.}$$

$$\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q) \mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}\left(n_1(q)\right) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}(n)\right\} = M_1 R_1$$

$$\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q)\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}\left(n_2(q)\right)\mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}(n)\right\} = M_2 R_2 \ .$$

17. (original) A method as in claim 1, wherein the means for digital signal processing in said first subset of MIMO-capable nodes further comprises:

an ADC bank for downconversion of received RF signals into digital signals;

a MT DEMOD element for multitone demodulation, separating the received signal into distinct tones and splitting them into 1 through ~~K~~ $\underline{K}_{\mathrm{feed}}$ FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT DEMOD element further comprising

a Comb element with a multiple of 2 filter capable of operating on a 128-bit sample; and,

an FFT element with a 1,024 real-IF function;

a Mapping element for mapping the demodulated multitone signals into a 426 active receive bins, wherein

each bin covers a bandwidth of 5.75MHz;

each bin has an inner passband of 4.26MHz for a content envelope;

each bin has an external buffer, up and down, of 745kHz;

each bin has 13 channels, CH0 through CH12, each channel having 320 kHz and 32 tones, T0 through T31, each tone being 10kHz, with the inner 30 tones being used information bearing and T0 and T31 being reserved;

each signal being 100μs, with 12.5μs at each end thereof at the front and rear end thereof forming respectively a cyclic prefix and cyclic suffix buffer to punctuate successive signals;

and,

a symbol-decoding element for interpretation of the symbols embedded in the signal.

18. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises

using at each node the receive combiner weights as transmit distribution weights during subsequent transmission operations, so that the network is preferentially designed and constrained such that each link is substantially reciprocal, such that the ad hoc network capacity measure can be made equal in both link directions by setting at both ends of the link:

$$\cancel{\mathrm{g}_2(\mathrm{q}) \propto \mathrm{w}^*{}_2(k,\mathrm{q}) \text{ and } \mathrm{g}_1(k,\mathrm{q}) \propto \mathrm{w}^*{}_1(k,\mathrm{q})}$$

$$\underline{\mathbf{g}_2(k,q) \propto \mathbf{w}_2^*(k,q) \text{ and } \mathbf{g}_1(k,q) \propto \mathbf{w}_1^*(k,q)},$$

where $\cancel{\{\mathrm{g}_2(k,\mathrm{q}), \mathrm{w}_1(k,\mathrm{q})\}}$ $\underline{\{\mathbf{g}_2(k,q), \mathbf{w}_1(k,q)\}}$ are the linear transmit and receive weights to transmit data $d_2(k,q)$ from node $n_2(q)$ to node $n_1(q)$ over channel k in the downlink, and where $\{\mathbf{g}_1(k,q),\mathbf{w}_2(k,q)\}$ are the linear transmit and receive weights used to transmit data $d_1(k,q)$ from node $n_1(q)$ back to node $n_2(q)$ over equivalent channel k in the uplink.

19. (currently amended) A method as in claim 1, wherein the step of each node in a transmit downlink / receive uplink subset having no more nodes with which it will hold

time and frequency coincident communications in its field of view, than it has diversity capability means further comprises:

designing the topological, physical layout of nodes to enforce this constraint within the node's diversity ~~channels~~ capability means limitations.

20. (currently amended) A method as in claim 1, wherein the step of each node in a transmit uplink / receive downlink subset having no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability means further comprises:

designing the topological, physical layout of nodes to enforce this constraint within the node's diversity ~~channels~~ capability means limitations.

21. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

allowing a proper subset to send redundant data transmissions over multiple frequency channels to another proper subset.

22. (original) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

allowing a proper subset to send redundant data transmissions over multiple simultaneous or differential time slots to another proper subset.

23. (original) A method as in claim 1, wherein said transmitting proper subset and receiving proper subset diversity capability means for transmission and reception of said analog radio ~~waves~~ signals further comprise:

spatial diversity of antennae.

24. (original) A method as in claim 1, wherein said transmitting proper subset and receiving proper subset diversity capability means for transmission and reception of said analog radio ~~waves~~ signals further comprise:

polarization diversity of antennae.

25. (original) A method as in claim 1, wherein said transmitting proper subset and receiving proper subset diversity capability means for transmission and reception of said analog radio ~~waves~~ signals further comprise:

any combination of temporal, spatial, and polarization diversity of antennae.

26. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

incorporating network control and feedback aspects as part of the signal encoding process.

27. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

incorporating network control and feedback aspects as part of the signal encoding process and including said as network information in one direction of the signalling and optimization process, using the perceived environmental

condition's effect upon the signals in the other direction of the signalling and optimization process.

28. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

adjusting the diversity ~~channel~~ capability means use between any proper sets of nodes by rerouting any active link based on perceived unacceptable SINR experienced on that active link and the existence of an alternative available link using said adjusted diversity ~~channel~~ capability means.

29. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

switching a particular node from one proper subset to another due to changes in the external environment affecting links between that node and other nodes in the network.

30. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

dynamically reshuffling proper subsets to more closely attain network objectives by taking advantage of diversity ~~channels~~ capability means availability.

31. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

dynamically reshuffling proper subsets to more closely attain network objectives by accounting for node changes.

32. (currently amended) A method as in claim 31, wherein said node changes include any of:

adding diversity capability means to a node, adding a new node within the field of view of another node, removing a node from the network (temporarily or permanently), or losing diversity capability means at a node.

33. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

suppressing unintended recipients or transmitters by the imposition of signal masking.

34. (original) A method as in claim 33, wherein the step of suppressing unintended recipients or transmitters by the imposition of signal masking further comprises:

imposition of an origination mask.

34. (original) A method as in claim 33, wherein the step of suppressing unintended recipients or transmitters by the imposition of signal masking further comprises:

imposition of a recipient mask.

35. (original) A method as in claim 33, wherein the step of suppressing unintended recipients or transmitters by the imposition of signal masking further comprises:

imposition of any combination of origination and recipient masks.

36. (currently amended) A method as in claim 33, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

using signal masking to secure transmissions against unintentional, interim interception and decryption by the imposition of a signal mask at origination, the transmission through any number of intermediate nodes lacking said signal mask, and the reception at the desired recipient which possesses the correct means for removal of the signal mask.

37. (original) A method as in claim 36, wherein the signal masking is shared by a proper subset.

38. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

heterogenous combination of a hierarchy of proper subsets, one within the other, each paired with a separable subset wherein the first is a transmit uplink and the second is a transmit downlink subset, such that the first subset of each pair of subsets is capable of communication with the members of the second subset of each pair, yet neither subset may communicate between its own members.

39. (original) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

using as many of the available diversity ~~channels~~ capability means as are needed for traffic between any two nodes from 1 to NumChannels, where NumChannels equals the maximal diversity capability means between said two nodes.

40. (original) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

~~usng~~ using a water-filling algorithm to route traffic between an origination and destination node through any intermediate subset of nodes that has available diversity ~~channel~~ capability means capacity.

41. (currently amended) A method for optimizing a wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set further comprising,

at least a first subset of MIMO-capable nodes, each MIMO-capable node comprising:

a spatially diverse antennae array of ~~M~~ *M* antennae, where ~~M~~ $M \geq$ two, said antennae array being polarization diverse, and circularly symmetric, and providing 1-to-M RF feeds;

a transceiver for each antenna in said array, said transceiver further comprising

a Butler Mode Forming element, providing spatial signature separation with a FFT-LS algorithm, reciprocally forming a transmission with shared receiver feeds, such that the number of modes out equals the numbers of antennae, establishing such as an ordered set with decreasing energy, further comprising:

a dual-polarization element for splitting the modes into positive and negative polarities with opposite and orthogonal polarizations, that can work with circular polarizations, and

a dual-polarized link CODEC;

a transmission/reception switch comprising,

a vector OFDM receiver element;

a vector OFDM transmitter element;

a LNA bank for a receive signal, said LNA Bank also instantiating low noise characteristics for a transmit signal;

a PA bank for the transmit signal that receives the low noise characteristics for said transmit signal from said LNA bank;

an AGC for said LNA bank and PA bank;

a controller element for said transmission/reception switch enabling baseband link distribution of the energy over the multiple RF feeds on each channel to steer up to ~~K~~ $\underline{K_{feed}}$ beams and nulls independently on each FDMA channel;

a Frequency Translator;

a timing synchronization element controlling said controller element;

further comprising a system clock,

a universal Time signal element;

GPS;

a multimode power management element and algorithm;

and,

a LOs element;

said vector OFDMreceiver element comprising

an ADC bank for downconversion of received RF signals into digital signals;

a MT DEMOD element for multitone demodulation, separating the received signal into distinct tones and splitting them into 1 through ~~K~~ $\underline{K_{feed}}$ FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT DEMOD element further comprising

a Comb element with a multiple of 2 filter capable of operating on a 128-bit sample; and,

an FFT element with a 1,024 real-IF function;

a Mapping element for mapping the demodulated multitone signals into a 426 active receive bins, wherein

each bin covers a bandwidth of ~~5.75MHz~~ 5.75 MHz;

each bin has an inner passband of ~~4.26MHz~~ 4.26 MHz for a content envelope;

each bin has an external buffer, up and down, of ~~745kHz~~ 745 kHz;

each bin has 13 channels, CH0 through CH12, each channel having 320 kHz and 32 tones, T0 through T31, each tone being ~~10kHz~~ 10 kHz, with the inner 30 tones being used

information bearing and T0 and T31 being reserved;

each signal being ~~100μs~~ 100 μs, with ~~12.5μs~~ 12.5 μs at each end thereof at the front and rear end thereof forming respectively a cyclic prefix and cyclic suffix buffer to punctuate successive signals;

a MUX element for timing modification capable of element-wise multiplication across the signal, which halves the number of bins and tones but repeats the signal for high-quality needs;

a link CODEC, which separates each FDMA channel into 1 through ~~M~~ M links, further comprising

a SOVA bit recovery element;

an error coding element;

an error detection element;

an ITI remove element;

a tone equalization element;

and,

a package fragment retransmission element;

a multilink diversity combining element, using a multilink Rx weight adaptation algorithm for Rx signal weights $\cancel{\mathbf{W}(k)}$ $\mathbf{W}(k)$ to adapt transmission gains $\cancel{\mathrm{G(k)}}$ $\mathbf{G}(k)$ for each channel ~~k~~ k;

an equalization algorithm, taking the signal from said multilink diversity combining element and controlling a delay removal element;

said delay removal element separating signal content from imposed pseudodelay and experienced environmental signal delay, and passing the content-bearing signal to a symbol-decoding element;

said symbol-decoding element for interpretation of the symbols embedded in the signal, further comprising:

an element for delay gating;

a QAM element; and

a PSK element;

said vector OFDM transmitter element comprising:

a DAC bank for conversion of digital signals into RF signals for transmission;

a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through ~~K~~ $\underline{K}_{\text{feed}}$ FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT MOD element further comprising

a Comb element with a multiple of 2 filter capable of operating on a 128-bit sample; and,

an IFFT element with a 1,024 real-IF function;

a Mapping element for mapping the modulated multitone signals from 426 active transmit bins, wherein

> each bin covers a bandwidth of ~~5.75MHz~~ 5.75 MHz;
>
> each bin has an inner passband of ~~4.26MHz~~ 4.26 MHz for a content envelope;
>
> each bin has an external buffer, up and down, of ~~745kHz~~ 745 kHz;
>
> each bin has 13 channels, CH0 through CH12, each channel having 320 kHz and 32 tones, T0 through T31, each tone being ~~10kHz~~ 10 kHz, with the inner 30 tones being used information bearing and T0 and T31 being reserved;
>
> each signal being ~~100μs~~ 100 μs, with ~~12.5μs~~ 12.5 μs at each end thereof at the front and rear end thereof forming respectively a cyclic prefix and cyclic suffix buffer to punctuate successive signals;

a MUX element for timing modification capable of element-wise multiplication across the signal, which halves the number of bins and tones but repeats the signal for high-quality needs;

a symbol-coding element for embedding the symbols to be interpreted by the receiver in the signal, further comprising:

an element for delay gating;

a QAM element; and

a PSK element;

a link CODEC, which aggregates each FDMA channel from 1 through ~~M~~ $\underline{M}$ links, further comprising

a SOVA bit recovery element;

an error coding element;

an error detection element;

an ITI remove element;

a tone equalization element;

and,

a package fragment retransmission element;

a multilink diversity distribution element, using a multilink Tx weight adaptation algorithm for Tx signal weights to adapt transmission gains ~~G(k)~~ $\underline{\mathbf{G}(k)}$ for each channel ~~k~~ k, such that ~~g(q;k) α w*(q;k)~~ $\underline{\mathbf{g}(q;k) \propto \mathbf{w}^{*}(q;k)}$;

a TCM codec;

a pilot symbol CODEC element that integrates with said FFT-LS algorithm a link separation, a pilot and data signal elements sorting, a link detection, multilink combination, and equalizer weight calculation operations;

means for diversity transmission and reception,

and,

means for input and output from and to a non-radio interface;

said set of nodes being deployed according to design rules that prefer meeting the following criteria:

said set of nodes further comprising two or more proper subsets of nodes, with a first proper subset being the transmit uplink / receive downlink set, and a second proper subset being the transmit downlink / receive uplink set;

each node in said set of nodes belonging to no more transmitting uplink or receiving uplink subsets than it has diversity capability means;

each node in a transmit uplink / receive downlink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability means;

each node in a transmit downlink / receive uplink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability means;

each member of a transmit uplink / receive downlink subset cannot hold time and frequency coincident communications with any other member of that transmit uplink / receive downlink subset;

and,

each member of a transmit downlink / receive uplink subset cannot hold time and frequency coincident communications with any other member of that transmit downlink / receive uplink subset;

transmitting, in said wireless electromagnetic communications network, independent information from each node belonging to a first proper subset, to one or more receiving nodes belonging to a second proper subset that are viewable from the transmitting node;

processing independently, in said wireless electromagnetic communications network, at each receiving node belonging to said second proper subset, information transmitted from one or more nodes belonging to said first proper subset;

and,

designing the network such that substantially reciprocal symmetry exists for the uplink and downlink channels by,

if the received interference is spatially white in both link directions, setting

$$\cancel{\mathbf{g}_1(a) \propto \mathbf{w}^*{}_2 q \text{ and } \mathbf{g}_2(q) \propto \mathbf{w}^*{}_1(q)}$$

$\underline{\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q) \text{ and } \mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)}$ at both ends of the link,

where $\cancel{\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}}$ $\underline{\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining $\cancel{\{\mathbf{g}_1(q)\} \text{ and } \{\mathbf{g}_2(q)\}}$ $\underline{\{\mathbf{g}_1(q)\} \text{ and } \{\mathbf{g}_2(q)\}}$ to satisfy:

$\cancel{Q_{21}}$

$$\cancel{\sum \mathbf{g}^T{}_1(q) \mathbf{R}_{i1i1}[\mathbf{n}_1(q)] \mathbf{g}^*{}_1(q) =}$$

$\cancel{q = 1}$

$\cancel{N_1}$

$\cancel{\sum \mathrm{Tr}\{R_{i1i1}(n)\} = M_1R_1}$

$\cancel{n=1}$

$\cancel{Q_{12}}$

$\cancel{\sum g^T{}_2(q)R_{i2i2}[n_2(q)]g^*{}_2(q) =}$

$\cancel{q = 1}$

$\cancel{n=1}$

$\cancel{\sum \mathrm{Tr}\{R_{i2i2}(n)\} = M_2R_{2,}}$

$\cancel{N_2}$

$$\underline{\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q)\mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}\left(n_1(q)\right)\mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}(n)\right\} = M_1R_1}$$

$$\underline{\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q)\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}\left(n_2(q)\right)\mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}(n)\right\} = M_2R_2;}$$

using any standard communications protocol, including TDD, FDD, simplex,

and,

optimizing the network by dynamically adapting the diversity ~~channels~~ capability means between nodes of said transmitting and receiving subsets.

42. (original) A method as in claim 41, wherein said a transmission/reception switch further comprises:

an element for tone and slot interleaving.

43. (original) A method as in claim 41, wherein said TMC codec and SOVA decoder are replaced with a Turbo codec.

44. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

optimizing at each node acting as a receiver the receive weights using ~~the~~ a MMSE technique to adjust the multitone transmissions between it and other nodes.

45. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

optimizing at each node acting as a receiver the receive weights using the ~~MAX~~ maximum SINR to adjust the multitone transmissions between it and other nodes.

46. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

optimizing at each node acting as a receiver the receive weights, then optimizing the transmit weights at that node by making them proportional to the receive

weights, and then optimizing the transmit gains for that node by a max-min criterion for the link capacities for that node at that particular time.

47. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

including, as part of said network, one or more network controller elements that assist in tuning local node's maximum ~~capactiy~~ capacity criteria and link channel diversity usage to network constraints.

48. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

characterizing the channel response vector $\mathbf{a}_1(f,t\,;n_2,n_1)$ by the observed (possibly time-varying) azimuth and elevation $\{\theta_1(t\,;n_2,n_1), \varphi_1(f,t\,;n_2,n_1)\}$ of node n_2 observed at n_1.

49. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

characterizing the channel response vector $\mathbf{a}_1(f,t\,;n_2,n_1)$ as a superposition of direct-path and near-field reflection path channel responses, e.g., due to scatterers in the vicinity of n_1, such that each element of $\mathbf{a}_1(f,t\,;n_2,n_1)$ can be modeled as a random process, possibly varying over time and frequency.

50. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

presuming that $\mathbf{a}_1(f,t;n_2,n_1)$ and $\mathbf{a}_1(f,t;n_{\cancel{2}[1]},n_{\cancel{1}[2]})$ can be substantively time invariant over significant time durations, e.g., large numbers of OFDM symbols or TDMA time frames, and inducing the most significant frequency and time variation by the observed timing and carrier offset on each link.

51. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

in such networks, e.g., TDD networks, wherein the transmit and receive frequencies are identical $(f_{21}(k)=f_{12}(k)=f(k))$ and the transmit and receive time slots are separated by short time intervals $(t_{21}(l)=t_{12}(l)+\Delta_{21} \approx t(l))$, and $\cancel{\mathbf{H}_{21}(k,l)\text{ and }\mathbf{H}_{21}(k,l)}$ □ $\underline{\mathbf{H}_{21}(k,l)\text{ and }\mathbf{H}_{12}(k,l)}$ become substantively reciprocal, such that the subarrays comprising $\cancel{\mathbf{H}_{21}(k,l)\text{ and }\mathbf{H}_{21}(k,l)}$ $\underline{\mathbf{H}_{21}(k,l)\text{ and }\mathbf{H}_{12}(k,l)}$ satisfy

$$\mathbf{H}_{21}(k,l;n_2,n_1)\approx\delta_{21}(k,l;n_1,n_2)\,\cancel{\mathbf{H}^T_{12}}\;\underline{\mathbf{H}^T_{12}}(k,l;n_1,n_2),$$

where $\delta_{21}(k,l;n_1,n_2)$ is a unit-magnitude, generally nonreciprocal scalar, equalizing the observed timing offsets, carrier offsets, and phase offsets, such that $\lambda_{21}(n_2,n_1)\approx\lambda_{12}(n_1,n_2)$, $\tau_{21}(n_2,n_1)\approx\tau_{12}(n_{\cancel{2}\underline{1}},n_{\cancel{1}\underline{2}})$, and $\nu_{21}(n_1,n_2)\approx\nu_{12}(n_{\cancel{2}\underline{1}},n_{\cancel{1}\underline{2}})$,by synchronizing each node to an external,

universal time and frequency standard, obtaining $\delta_{21}(k\,,l\,;\; n_{\cancel{1}[2]}\,, n_{\cancel{2}[1]}) \approx 1$, and establishing network channel response as truly reciprocal $\mathbf{H}_{21}\,(k\,,l\,) \approx \cancel{\mathbf{H}^{T}_{21}}\ \underline{\mathbf{H}^{T}_{12}}\ (k,l)$.

52. A method as in claim 51, wherein the synchronization of each node is to Global Position System Universal Time Coordinates (GPS UTC).

53. (original) A method as in claim 51, wherein the synchronization of each node is to a network timing signal.

54. (original) A method as in claim 51, wherein the synchronization of each node is to a combination of Global Position System Universal Time Coordinates (GPS UTC) and a network timing signal.

55. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ <u>capability means</u> and said proper subsets to optimize said network further comprises:

for such parts of the network where the internode channel responses possess substantive multipath, such that $\mathbf{H}_{21}(k\,,\,l\,;n_2\,,n_1)$ and $\mathbf{H}_{\cancel{21}\,\underline{12}}(k\,,\,l\,;n_{\cancel{2}\underline{1}}\,,n_{\cancel{1}\underline{2}})$ have rank greater than unity, making the channel response substantively reciprocal by:

(1) forming uplink and downlink transmit signals using the matrix formula ~~in EQ. 40~~

$$\mathbf{s}_1(k,l;n_1) = \mathbf{G}_1(k,l;;n_1)\,\mathbf{d}_1(k,l;;n_1)$$

$$\mathbf{s}_2(k,l;n_1) = \mathbf{G}_2(k,l;n_2)\,\mathbf{d}_2(k,l;n_2);$$

(2) reconstructing the data intended for each receive node using the matrix formula ~~in EQ. 41~~

$$\mathbf{y}_1(k,l;n_1) = \mathbf{W}^H{}_1(k,l;n_1)\ \mathbf{x}_1(k,l;n_1)$$

$$\mathbf{y}_2(k,l;n_2) = \mathbf{W}^H{}_2(k,l;n_2)\ \mathbf{x}_2(k,l;n_2);$$

(3) developing combiner weights that $\{\mathbf{w}_1(k,l;n_2,n_1)\}$ and $\{\mathbf{w}_2(k,l;n_1,n_2)\}$ that substantively null data intended for recipients during the symbol recovery operation, such that for $n_1 \neq n_2$:

(4) developing distribution weights $\{\mathbf{g}_1(k,l;n_2,n_1)\}$ and $\{\mathbf{g}_2(k,l;n_1,n_2)\}$ that perform equivalent substantive nulling operations during transmit signal formation operations;

(5) scaling distribution weights to optimize network capacity and/or power criteria, as appropriate for the specific node topology and application addressed by the network;

(6) removing residual timing and carrier offset remaining after recovery of the intended network data symbols;

and

(7) encoding data onto symbol vectors based on the end-to-end SINR obtainable between each transmit and intended recipient node, and

decoding that data after symbol recovery operations, using channel coding and decoding methods develop in prior art.

56. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

forming substantively nulling combiner weights using an FFT-based least-squares algorithms that adapt $\{\mathbf{w}_1(k,l;n_2,n_1)\}$ and $\{\mathbf{w}_2(k,l;n_1,n_2)\}$ to values that minimize the mean-square error (MSE) between the combiner output data and a known segment of transmitted pilot data;

applying the pilot data to an entire OFDM symbol at the start of an adaptation frame comprising a single OFDM symbol containing pilot data followed by a stream of OFDM symbols containing information data;

wherein the pilot data transmitted over the pilot symbol is preferably given by ~~EQ. 44 and EQ. 45,~~

$$
\begin{aligned}
p_1(k;n_2,n_1) &= d_1(k,1;n_2,n_1) \\
&= p_{01}(k)\,p_{21}(k;n_2)\,p_{11}(k;n_1) \\
p_2(k;n_1,n_2) &= d_2(k,1;n_1,n_2) \\
&= p_{02}(k)\,p_{12}(k;n_1)\,p_{22}(k;n_2)
\end{aligned}
$$

such that the "pseudodelays" $\delta_1(n_1)$ and $\delta_2(n_2)$ are unique to each transmit node (in small networks), or provisioned at the beginning of communication with

any given recipient node (in which case each will be a function of n_1 and n_2), giving each pilot symbol a pseudorandum component;

maintaining minimum spacing between any pseudodelays used to communicate with a given recipient node that is larger than the maximum expected timing offset observed at that recipient node, said spacing should also being an integer multiple of $1/K$, where K is the number of tones used in a single FFT-based LS algorithm;

and if K is not large enough to provide a sufficiency of pseudodelays, using additional OFDM symbols for transmission of pilot symbols, either lengthening the effective value of K, or reducing the maximum number of originating nodes transmitting pilot symbols over the same OFDM symbol;

also providing K large enough to allow effective combiner weights to be constructed from the pilot symbols alone;

then obtaining the remaining information-bearing symbols, which are the uplink and downlink data symbols provided by prior encoding, encryption, symbol randomization, and channel preemphasis stages, in the adaptation frame, by using ~~EQ. 46 and EQ. 47~~

$$d_1(k,l;n_2,n_1) \quad = \quad p_1(k;n_2,n_1)\, d_{01}(k,l;n_2,n_1)$$

$$d_2(k,l;n_1,n_2) \quad = \quad p_2(k;n_1,n_2)\, d_{02}(k,l;n_1,n_2);$$

removing at the recipient node, first the pseudorandom pilot components from the received data by multiplying each tone and symbol by the pseudorandom components of the pilot signals, using ~~EQ. 47 and EQ. 48~~

$$d_2(k, l; n_1, n_2) = p_2(k; n_1, n_2)\, d_{02}(k, l; n_1, n_2)$$

$$\mathbf{x}_{02}(k, l; n_2) = c_{01}(k; n_2)\, \mathbf{x}_2(k, l; n_2);$$

thereby transforming each authorized and intended pilot symbol for the recipient node into a complex sinusoid with a slope proportional to the sum of the pseudodelay used during the pilot generation procedure, and the actual observed timing offset for that link, and leaving other, unauthorized pilot symbols, and symbols intended for other nodes in the network, untransformed and so appearing as random noise at the recipient node.

57. (currently amended) A method as in claim 55, wherein the FFT-Least Squares algorithm~~ is that shown in Figure 37.~~ further comprises:

using a pilot symbol, which is multiplied by a unit-norm FFT window function;

passing that result to a QR decomposition algorithm and computing orthogonalized data $\{\mathbf{q}(k)\}$ and an upper-triangular Cholesky statistics matrix **R**;

then multiplying each vector element of $\{\mathbf{q}(k)\}$ by the same unit-norm FFT window function and passing it through a zero-padded inverse Fast Fourier Transform (IFFT) with output length *PK*, with padding factor *P* to form uninterpolated, spatially whitened processor weights $\{\mathbf{u}(m)\}$, where lag index m is proportional to target pseudodelay $\delta(m) = m/PK$;

then using the spatially whitened processor weights to estimate the mean-square-error (MSE) obtaining for a signal received at each target pseudodelay, $\varepsilon(m) = 1 - \|\mathbf{u}(m)\|^2$, yielding a detection statistic (pseudodelay indicator function), with an extreme at IFFT lags commensurate with the observed

pseudodelay and designed to minimize interlag interference between pilot signal features in the pseudodelay indicator function;

using an extremes-finding algorithm to detect each extreme;

estimating the location of the observed pseudodelays to sub-lag accuracy;

determining additional ancillary statistics;

selecting the extremes beyond a designated MSE threshold;

interpolating spatially whitened weights **U** from weights near the extremes;

using the whitened combiner weights **U** to calculate both unwhitened combiner weights $\mathbf{W} = \mathbf{R}^{-1}\mathbf{U}$ to be used in subsequent data recovery operations, and to estimate the received channel aperture matrix $\mathbf{A} = \mathbf{R}^{H}\mathbf{U}$, to facilitate ancillary signal quality measurements and fast network entry in future adaptation frames; and, lastly,

using an estimated and optimized pseudodelay vector $\boldsymbol{\delta}_{*}$ to generate $\mathbf{c}_1(k) = \exp\{-j2\pi\boldsymbol{\delta}_{*}k\}$ (conjugate of $\{p_{11}(k;n_1)\}$ during uplink receive operations, and $\{p_{22}(k;n_2)\}$ during downlink receive operations), which is then used to remove the residual observed pseudodelay from the information bearing symbols.

58. (original) A method as in claim 55, wherein the pseudodelay estimation is refined using a Gauss-Newton recursion using the approximation :

$$\exp\{-j2\pi\Delta(k-k_0)/\mathrm{PK}\} \approx 1 - j2\pi\Delta(k-k_0)/PK.$$

59. (currently amended) A method as in claim 1, wherein wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

using the linear combiner weights provided during receive operations are construct linear distribution weights during subsequent transmit operations, by setting distribution weight $\mathbf{g}_1(k,l;n_2,n_1)$ proportional to $\mathbf{w}^*{}_1(k,l;n_2,n_1)$ during uplink transmit operations, and $\mathbf{g}_2(k,l;n_1,n_2)$ proportional to $\mathbf{w}^*{}_2(k,l;n_1,n_2)$ during downlink transmit operations; thereby making the transmit weights substantively nulling and thereby allowing each node to form frequency and time coincident two-way links to every node in its field of view, with which it is authorized (through establishment of link set and transfer of network/recipient node information) to communicate.

60. (original) A method as in claim 1, wherein each node in the first subset of nodes further comprises:

a LEGO implementation element and algorithm.

61. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

balancing the power use against capacity for each channel, link, and node, and hence for the network as a whole by:

establishing a capacity objective ~~B~~ $\{\beta(m)\}$ for a ~~particular Node 2~~ user 2 node receiving from a user 1 node ~~another Node 1~~ as the target to be achieved by the user 2 node ~~node 2~~;

solving, at the user 2 node ~~Node 2~~ the local optimization problem:

$$\min \Sigma_q \pi_1(q) \cancel{=} = \mathbf{1}^T \boldsymbol{\pi}_1, \text{ such that}$$

$$\Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m),$$

where $\pi_1(q)$ is the ~~SU (user 1 node)~~ transmit power for link number $\cancel{q}$ q for the user 1 node,

$\gamma(q)$ is the signal to interference and noise ratio (SINR) seen at the output of the beamformer,

$\mathbf{1}$ is a vector of all 1s,

and,

$\boldsymbol{\pi}_1$ is a vector whose ~~q^{th} element is $\pi_1(q)$~~ q^{th} element is $\pi_1(q)$,

the aggregate set ~~$Q(m)$~~ $Q(m)$ contains a set of links that are grouped together for the purpose of measuring capacity flows through those links;

using at ~~Node 2~~ the user 2 node the local optimization solution to moderate the transmit and receive weights, and signal information, returned to ~~node 1~~ user 1 node;~~,~~

and,

using said feedback to compare against the capacity objective ~~B~~ $\{\beta(m)\}$ and incrementally adjust the transmit power at each of ~~Node 1~~ the user 1 node and ~~Node 2~~ the user 2 node until no further improvement is perceptible.

62. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

using the downlink objective function ~~in EQ. 5 and EQ. 6~~

$$\min \Sigma_q \pi_2(q) = 1^T \boldsymbol{\pi}_2 \text{ such that } \Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$$

at each node to perform local optimization;

reporting the required feasibility condition, $\cancel{\Sigma_{q \in Q(m)} \pi_1(q) \leq R_1(m)}$

$\underline{\Sigma_{q \in Q(m)} \pi_1(q) \leq R_1(m)}$;

and,

modifying $\beta(m)$ as necessary to stay within the constraint.

63. (original) A method as in claim ~~60~~ <u>61</u>, wherein:

the capacity constraints $\beta(m)$ are determined in advance for each proper subset of nodes, based on known QoS requirements for each said proper subset.

64. (currently amended) A method as in claim ~~60~~ <u>61</u>, wherein said network further seeks to minimize total power in the network as suggested by ~~EQ. 4~~

$$\Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m).$$

65. (currently amended) A method as in claim ~~60~~ <u>61</u>, wherein said network sets as a target objective for the network ~~B~~ $\underline{\{\beta(m)\}}$ the QoS for the network.

66. (currently amended) A method as in claim ~~60~~ 61, wherein said network sets as a target objective for the network ~~**B**~~ $\{\beta(m)\}$ a vector of constraints.

67. (currently amended) A method as in claim ~~60~~ 61, wherein the local optimization problem is further defined such that:

the receive and transmit weights are unit normalized with respect to the background interference autocorrelation matrix;

the local SINR is expressed as ~~EQ. 8~~

$$\gamma(q) = \frac{P_{rt}(q,q)\pi_t(q)}{1 + \sum_{j \neq q} P_{rt}(q,j)\pi_t(j)};$$

and the weight normalization ~~in EQ. 6~~

$$\Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$$

is used to enable $D_{12}(\mathbf{W},\mathbf{G}) = D_{21}(\mathbf{G}^*,\mathbf{W}^*)$, where $(\mathbf{W}_2,\mathbf{G}_1)$ and $(\mathbf{W}_1,\mathbf{G}_2)$ represent the receive and transmit weights employed by all nodes in the network during uplink and downlink operations, respectively, ~~the reciprocity equation~~ at that node, thereby allowing the uplink and downlink function to be presumed identical rather than separately computed.

68. (currently amended) A method as in claim ~~60~~ 61, wherein:

very weak constraints to the transmit powers are approximated by using a very simple approximation for ~~$\gamma(q)$~~ $\gamma(q)$.

69. (currently amended) A method as in claim ~~60~~ 61, for the cases wherein all the aggregate sets contain a single link and non-negligible environmental noise is present, wherein the transmit powers are computed as Perron vectors from ~~EQ. 10,~~

$$
\begin{aligned}
D_{21} &= \log\left(1+\frac{1}{\rho\left(\mathbf{P}_{21}\right)-1}\right)\\
&= \log\left(1+\frac{1}{\rho\left(\mathbf{P}_{12}^{T}\right)-1}\right) \qquad ;\\
&= D_{12}
\end{aligned}
$$

and a simple power constraint is imposed upon the transmit powers.

70. (currently amended) A method as in claim ~~60~~ 69, wherein the optimization is performed in alternating directions and repeated.

71. (currently amended) A method as in claim ~~60~~ 61, wherein each node presumes the post-beamforming interference energy remains constant for the adjustment interval and so solves ~~EQ. 3~~

$$\min_{\pi_1(q)} \sum_{q} \pi_1(q) = \mathbf{1}^T \boldsymbol{\pi}_1$$, subject to the constraint of

$$\Sigma_{q \in Q(m)} \log(1+\gamma(q)) \geq \beta(m)$$

using classic water filling arguments based on Lagrange multipliers, and then uses a similar equation for the reciprocal element of the link.

72. (currently amended) Amethod as in claim ~~60~~ 61, wherein at each node the constrained optimization problem stated in ~~EQ. 13 and 14~~

$$\max_{m} \sum_{q \in Q(m)} \log\left(1+\gamma(q)\right), \text{ such that}$$

$$\sum_{q \in Q(m)} \pi_1(q) \leq R_1(m),\ \gamma(q) \geq 0$$

is solved using the approximation ~~in EQ. 11,~~

$$\gamma(q) = \frac{P_{21}(q,q)\pi_1(q)}{i_2(q)}$$

and the network further comprises at least one high-level network controller that controls the power constraints ~~$R_1(q)$~~ $R_1(m)$, and drives the network towards a max-min solution.

73. (currently amended) A method as in claim ~~60~~ 61, wherein each node:

is given an initial γ_0;

generates the model expressed in ~~EQ. 20, EQ. 21, and EQ. 22~~

$$L(\gamma, \mathbf{g}, \beta) = \mathbf{g}^T \gamma,\ \Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$$

$$\mathbf{g} = \nabla_\gamma f(\gamma_0) \quad ;$$

updates the new γ_α from ~~EQ. 23 and EQ. 24~~

$$\gamma_* = \arg\min_\gamma L(\gamma, \mathbf{g}, \beta),\ \gamma_\alpha = \gamma_0 + \alpha\left(\gamma_* - \gamma_0\right) ;$$

determines a target SINR to adapt to; and,

updates the transmit power for each link q according to ~~EQ. 25 and EQ. 26~~

$$\pi_2(q) = \gamma_\alpha i_1(q) / \left|h(q)\right|^2$$

$$\pi_1(q) = \gamma_\alpha\, i_2(q) \Big/ \left|h(q)\right|^2 .$$

74. (currently amended) A method as in claim ~~60~~ 61, for each node wherein the transmit power relationship of ~~EQ. 25 and EQ 26~~

$$\pi_2(q) = \gamma_\alpha\, i_1(q) \Big/ \left|h(q)\right|^2$$

$$\pi_1(q) = \gamma_\alpha\, i_2(q) \Big/ \left|h(q)\right|^2$$

is not known, that:

uses a suitably long block of N samples is used to establish the relationship, where N is either 4 times the number of antennae or 128, whichever is larger;

uses the result to update the receive weights at each end of the link;

optimizes the local model as in ~~EQ. 23 and EQ. 24~~

$$\gamma_* = \arg\min_\gamma L\,(\gamma, \mathbf{g}, \beta)$$

$$\gamma_\alpha = \gamma_0 + \alpha\left(\gamma_* - \gamma_0\right);$$

and then applies

$$\pi_2(q) = \gamma_\alpha\, i_1(q) \Big/ \left|h(q)\right|^2$$

$$\pi_1(q) = \gamma_\alpha\, i_2(q) \Big/ \left|h(q)\right|^2$$ ~~EQ. 25 and EQ. 26~~.

75. (currently amended) A method as in claim ~~60~~ 61 that, for an aggregate proper subset m:

for each node within the set m, inherits the network objective function model given in ~~EQ. 28, EQ. 29, and EQ. 30~~

$$L_m\,(\gamma, \mathbf{g}, \beta) = \Sigma_{q \in Q(m)}\, \mathbf{g}_q\, \gamma(q)$$

$$\Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$$

$$\underline{g(q) = i_1(q) i_2(q) \Big/ \left|h(q)\right|^2} \quad ;$$

eliminates ~~the~~ a step of matrix channel estimation, transmitting instead from that node as a single real number for each link to the other end of said link an estimate of the post beamforming interference power;

and ,

receives back for each link a single real number being the transmit power.

76. (original) A method as in claim ~~75~~ 74 , that for each pair of nodes assigns to the one presently possessing the most processing capability the power management computations.

77. (currently amended) A method as in claim ~~74~~ 75 that estimates the transfer gains and the post beamforming interference power using simple least squares estimation techniques.

78. (currently amended) A method as in claim ~~74~~ 75 that, for estimating the transfer gains and post beamforming interference power:

instead solves for the transfer gain h using ~~EQ. 31~~

$$\underline{y(n) = hgs(n) + \varepsilon(n);}$$

uses a block of N samples of data to estimate h using ~~EQ. 32~~

$$\underline{h = \frac{\sum_{n=1}^{N} s^*(n) y(n)}{\sum_{n=1}^{N} \left|s(n)\right|^2 g}} \quad ;$$

obtains an estimation of residual interference power $\cancel{R_e}$ $\underline{R_\varepsilon}$ using ~~EQ. 33~~

$$
\begin{aligned}
R_{\varepsilon} &= \left\langle \left|\varepsilon(n)\right|^{2} \right\rangle \\
&= \frac{1}{N}\sum_{n=1}^{N}\left(\left|y(n)\right|^{2} - \left|ghs(n)\right|^{2}\right)
\end{aligned}
;
$$

and,

obtains knowledge of the transmitted data symbols $s(n)$ from using remodulated symbols at the output of the codec.

79. (currently amended) A method as in claim ~~77~~ 78 wherein, instead of obtaining knowledge of the transmitted data symbols $s(n)$ from using remodulated symbols at the output of the codec, the node uses the output of a property restoral algorithm used in a blind beamforming algorithm.

80. (currently amended) A method as in claim ~~77~~ 78 wherein, instead of obtaining knowledge of the transmitted data symbols $s(n)$ from using remodulated symbols at the output of the codec, the node uses a training sequence explicitly transmitted to train beamforming weights and asset the power management algorithms.

81. (currently amended) A method as in claim ~~77~~ 78 wherein, instead of obtaining knowledge of the transmitted data symbols $s(n)$ from using remodulated symbols at the output of the codec, the node uses any combination of:

the output of a property restoral algorithm used in a blind beamforming algorithm;

a training sequence explicitly transmitted to train beamforming weights and asset the power management algorithms;

or,

other means known to the art.

82. (currently amended) A method as in claim ~~60~~ 61, wherein each node incorporates a link level optimizer and a decision algorithm~~, as illustrated in Figure 32Aand 32B~~.

83. (currently amended) A method as in claim ~~81~~ 82, wherein the decision algorithm is a Lagrange multiplier technique.

84. (currently amended) A method as in claim ~~60~~ 61, wherein the solution to ~~EQ. 3~~ $\underline{\min_{\pi_1(q)} \sum_q \pi_1(q) = \mathbf{1}^T \boldsymbol{\pi}_1}$ is implemented by a penalty function technique.

85. (currently amended) A method as in claim ~~83~~ 84, wherein the penalty function technique:

takes the derivative of $\cancel{\gamma(q)}$ $\underline{\gamma(q)}$ with respect to π_1;

and,

uses the Kronecker-Delta function and the weighted background noise.

86. (currently amended) A method as in claim ~~83~~ 84, wherein the penalty function technique neglects the noise term.

87. (currently amended) A method as in claim ~~83~~ 84, wherein the penalty function technique normalizes the noise term to one.

88. (currently amended) A method as in claim ~~60~~ 61, wherein the approximation uses the receive weights.

89. (currently amended) A method as in claim ~~60~~ 61, wherein adaptation to the target objective is performed in a series of measured and quantized descent and ascent steps.

90. (currently amended) A method as in claim ~~60~~ 61, wherein the adaptation to the target objective is performed in response to information stating the vector of change.

91. (currently amended) A method as in claim ~~60~~ 61, which uses the log linear mode ~~in EQ. 34~~

$$\underline{\beta_q \approx \log\left(\frac{a\ \pi_1(q)+a_0}{b\ \pi_1(q)+b_0}\right) = \hat{\beta}_q\left(\pi_1(q)\right)}$$

and the inequality characterization ~~in EQ. 35~~ $\underline{\hat{\beta}_q\left(\pi_1(q)\right) \geq \beta}$ to solve the approximation problem with a simple low dimensional linear program.

92. (currently amended) A method as in claim~~60~~ 61, develops the local mode by matching function values and gradients between the current model and the actual function.

93. (currently amended) A method as in claim ~~60~~ 61, which develops the model as a solution to the least squares fit, evaluated over several points.

94. (currently amended) A method as in claim ~~60~~ 61, which reduces the cross-coupling effect by allowing only a subset of links to update at any one particular time, wherein the subset members are chosen as those which are more likely to be isolated from one another.

95. (currently amended) A method as in claim ~~60~~ 61, wherein:

the network further comprises a network controller element;

said network controller element governs a subset of the network;

said network controller element initiates, monitors, and changes the target objective for that subset;

said network controller communicates the target objective to each node in that subset;

and,

receives information from each node concerning the adaptation necessary to meet said target objective.

96. (currently amended) A method as in claim ~~94~~ 95, wherein said network further records the scalar and history of the increments and decrements ordered by the network controller.

97. (currently amended) A method as in claim~~60~~ 61, wherein for any subset, a target objective may be a power constraint.

98. (currently amended) A method as in claim~~60~~ 61, wherein for any subset, a target objective may be a capacity maximization subject to a power constraint.

99. (currently amended) A method as in claim ~~60~~ 61, wherein for any subset, a target objective may be a power minimization subject to the capacity attainment to the limit possible over the entire network.

100. (currently amended) A method as in claim ~~60~~ 61, wherein for any subset, a target objective may be a power minimization at each particular node in the network subject to the capacity constraint at that particular node.

101. (currently amended) A wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

a spatially diverse antennae array of M antennae, where M $\geq$ one,

a transceiver for each antenna in said array,

means for digital signal processing,

means for coding and decoding data and symbols,

means for diversity transmission and reception,

and,

means for input and output from and to a non-radio interface;

said set of nodes further comprising one or more proper subsets of nodes, being at least one transmitting and at least one receiving subset, with said transmitting and receiving subsets having a topological arrangement whereby:

each node in a transmitting subset has no more nodes with which it will simultaneously communicate in its field of view, than it has number of antennae;

each node in a receiving subset has no more nodes with which it will simultaneously communicate in its field of view, than it can steer independent nulls to;

and,

each member of a non-proper subset cannot communicate with any other member of its non-proper subset;

transmitting independent information from each node in a first non-proper subset to one or more receiving nodes belonging to a second non-proper subset that are viewable from the transmitting node;

processing independently information transmitted to a receiving node in a second non-proper subset from one or more nodes in a first non-proper subset is independently by the receiving node;

and,

optimizing the network by dynamically adapting the ~~diversity channels~~ means for diversity transmission and reception between nodes of said transmitting and receiving subsets.

102. (currently amended) An apparatus as in claim ~~100~~ 101, further comprising an element for scheduling according to a Demand-Assigned, Multiple-Access algorithm.

103. (currently amended) An apparatus as in claim ~~100~~ 101, further comprising for each node in said first subset a LEGO adaptation element.

104. (currently amended) An apparatus as in claim ~~100~~ 101, further comprising:

for each node in said first subset a LEGO adaptation element; and,

one or more network controllers.

105. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network further comprises:

matching each transceiver's degrees of freedom (DOF) to the nodes in the possible link directions;

equalizing those links to provide node-equivalent uplink and downlink capacity.

106. (original) A method as in claim 105, further comprising, after the DOF matching:

assigning asymmetric transceivers to reflect desired capacity weighting;

adapting the receive weights to form a solution for multipath resolutions;

employing data and interference whitening as appropriate to the local conditions; and,

using retrodirective transmission gains during subsequent transmission operations.

107. (original) A method as in claim 105, wherein the receive weights are ~~similarly modified~~ matched to the nodes in the possible link directions.

108. (currently amended) A method for optimizing a wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set of nodes further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

an antennae array of ~~M~~ M antennae, where ~~M~~ $M \geq$ one,

a transceiver for each antenna in said spatially diverse antennae array,

means for digital signal processing to convert analog radio signals into digital signals and digital signals into analog radio signals,

means for coding and decoding data, symbols, and control information into and from digital signals,

diversity capability means for transmission and reception of said analog radio ~~waves~~ signals;

and,

means for input and output from and to a non-radio interface for digital signals;

said set of nodes being deployed according to design rules that prefer meeting the following criteria:

said set of nodes further comprising two or more proper subsets of nodes, with a first proper subset being the transmit uplink / receive downlink set, and a second proper subset being the transmit downlink / receive uplink set;

each node in said set of nodes belonging to no more transmitting uplink or receiving uplink subsets than it has diversity capability means;

each node in a transmit uplink / receive downlink subset has no more nodes with which it will hold time and frequency coincident communications in its field of view, than it has diversity capability means;

each node in a transmit downlink / receive uplink subset has no more nodes with which it will hold time and frequency coincident

communications in its field of view, than it has diversity capability <u>means;</u>

each member of a transmit uplink / receive downlink subset cannot hold time and frequency coincident communications with any other member of that transmit uplink / receive downlink subset; and,

each member of a transmit downlink / receive uplink subset cannot hold time and frequency coincident communications with any other member of that transmit downlink / receive uplink subset;

transmitting, in said wireless electromagnetic communications network, independent information from each node belonging to a first proper subset, to one or more receiving nodes belonging to a second proper subset that are viewable from the transmitting node;

processing independently, in said wireless electromagnetic communications network, at each receiving node belonging to said second proper subset, information transmitted from one or more nodes belonging to said first proper subset;

optimizing at the local level for each node for the channel capacity ~~D~~ $\underline{D}_{21}$ according to ~~EQ. 49,~~

$$
\begin{aligned}
D_{21} &= \max \beta \text{ such that} \\
\beta &\le \sum_{q \in U(m)} \sum_{k} \log\left(1+\gamma\left(k,q\right)\right), \\
\gamma(k,q) &\ge 0, \\
\sum_{m} R_1\left(m\right) &\le R, \\
\pi_1\left(k,q\right) &\ge 0, \\
\sum_{q \in U(m)} \sum_{k} \pi_1\left(k,q\right) &\le R_1(m)
\end{aligned}
\qquad ;
$$

solving first the reverse link power control problem; then treating the forward link problem in an identical fashion, substituting the subscripts 2 for 1 in said equation;

and,

dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said network.

109. (currently amended) A method as in claim 108, futher comprising:

for each aggregate subset m, attempting to achieve the given capacity objective, $\cancel{\beta}$ $\underline{\beta}$, as described in

$$\underline{\min_{\pi_r(q)} \Sigma_{q \in Q(m)} \pi_r(q),} \quad \underline{\text{such that}}$$

$$\underline{\beta = \Sigma_{q \in Q(m)} \log\left(1+\gamma(q)\right)}$$

~~EQ. 50~~, by:

(1) optimizing the receive beamformers, using simple MMSE processing, to simultaneously optimize the SINR;

(2) based on the individual measured SINR for each ~~q~~ q index, attempt to incrementally increase or lower its capacity as needed to match the current target; and,

(3) ~~steping~~ stepping the power by a quantized small step in the appropriate direction;

then,

when all aggregate sets have achieved the current target capacity, then the network can either increase the target capacity β, or add additional users to exploit the now-known excess capacity.

110. (currently amended) A method as in claim ~~106~~ 107, wherein ~~instead of optimizing for channel [capability means] capacity,~~ the network optimizes for QoS and not diversity capability means capacity.

111. (currently amended) A method as in claim ~~94~~ 95, wherein:

said network controller adds, drops, or changes the target capacity for any node in the set the network controller controls.

112. (currently amended) A method as in claim ~~94~~ 95, wherein:

said network controller may, either in addition to or in replacement for altering β, add, drop, or change channels between nodes, frequencies, coding, security, or protocols, polarizations, or traffic density allocations usable by a particular node or channel.

113. (currently amended) A wireless electromagnetic communications network, comprising:

a set of nodes, said set further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

a spatially diverse antennae array of ~~M~~ $\underline{M}$ antennae, where ~~M~~ $\underline{M} \geq$ one,

a transceiver for each antenna in said array,

~~13~~ means for digital signal processing,

~~14~~ means for coding and decoding data and symbols,

~~19~~ means for diversity transmission and reception,

pilot symbol coding & decoding element

timing synchronization element

and,

means for input and output from and to a non-radio interface;

said set of nodes further comprising two or more proper subsets of nodes, there being at least one transmitting and at least one receiving subset, with said transmitting and receiving subsets subset having a diversity arrangement whereby:

each node in a transmitting subset has no more nodes with which it will simultaneously communicate in its field of view, than it has number of antennae;

each node in a receiving subset has no more nodes with which it will simultaneously communicate in its field of view, than it can steer independent nulls to;

and,

each member of a non-proper subset cannot communicate with any other member of its non-proper subset over identical diversity channels;

a LEGO adaptation element and algorithm;

a network controller element and algorithm;

whereby each node in a first non-proper subset transmits independent information to one or more receiving nodes belonging to a second non-proper subset that are viewable from the transmitting node;

each receiving node in said second non-proper subset processes independently information transmitted to a from one or more nodes in a first non-proper subset is independently by the receiving node;

each node uses means to minimize SINR between nodes transmitting and receiving information;

the network is designed such that substantially reciprocal symmetry exists for the uplink and downlink channels by,

if the received interference is spatially white in both link directions, setting

$\cancel{g_1(aq) \propto w^*{}_2 q}$ ~~and~~ $\cancel{g_2(q) \propto w^*{}_1(q)}$

$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$ at both ends of the link,

where $\cancel{\{g_2(q), w_1(q)\}}$ $\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$ are the linear transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link directions, constraining $\cancel{\{g_1(q)\}}$ ~~and~~ $\cancel{\{g_2(q)\}}$

$\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$ to satisfy:

$$\cancel{\frac{\sum_{q=1}^{Q_{21}} g^T{}_1(q) R_{i1i1}[n_1(q)] g^*{}_1(q)}{\sum_{n=1}^{N_1} \mathrm{Tr}\{R_{i1i1}(n)\}} = M_1 R_1;}$$

$\cancel{Q_{12}}$

$\cancel{\sum g^T{}_2(q)R_{i2i2}[n_2(q)]g^*{}_2(q) =}$

$\cancel{q=1}$

$\cancel{n=1}$

$\cancel{\sum \mathrm{Tr}\{R_{i2i2}(n)\} = M_2R_2,}$

$\cancel{N_2}$

$$\underline{\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q)\mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}\left(n_1(q)\right)\mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_1\mathbf{i}_1}(n)\right\} = M_1R_1}$$

$$\underline{\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q)\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}\left(n_2(q)\right)\mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \mathrm{Tr}\left\{\mathbf{R}_{\mathbf{i}_2\mathbf{i}_2}(n)\right\} = M_2R_2}$$

;

the network uses any standard communications protocol;

and,

the network is optimized by dynamically adapting the <u>means for diversity transmission and reception</u> ~~diversity~~ ~~channels~~ between nodes of said transmitting and receiving subsets.

114. (currently amended) A wireless electromagnetic communications network as in claim ~~112~~ <u>113</u>:

wherein each node may further comprise a Butler Mode Forming element, to enable said node to ratchet the number of active antennae for a particular uplink or downlink operation up or down.

115. (currently amended) A wireless electromagnetic communications network as in claim ~~50~~ 101:

incorporating a dynamics-resistant multitone element.

116. (original) The use of a method as described in claim 1 for fixed wireless electromagnetic communications.

117. (currently amended) The use of an apparatus as described in claim ~~50~~ 101 for fixed wireless electromagnetic communications.

118. (original) The use of a method as described in claim 1 for mobile wireless electromagnetic communications.

119. (currently amended) The use of an apparatus as described in claim ~~50~~ 101 for mobile wireless electromagnetic communications.

120. (original) The use of a method as described in claim 1 for mapping operations using wireless electromagnetic communications.

121. (currently amended) The use of an apparatus as described in claim ~~50~~ 101 for mapping operations using wireless electromagnetic communications.

122. (original) The use of a method as described in claim 1 for a military wireless electromagnetic communications network.

123. (currently amended) The use of an apparatus as described in claim ~~50~~ 101 for a military wireless electromagnetic communications network.

124. (original) The use of a method as described in claim 1 for a military wireless electromagnetic communications network for battlefield operations.

125. (currently amended) The use of an apparatus as described in claim ~~50~~ 101 for a military wireless electromagnetic communications network for battlefield operations.

126. (original) The use of a method as described in claim 1 for a military wireless electromagnetic communications network for Back Edge of Battle Area (BEBA) operations.

127. (original) The use of an apparatus as described in claim ~~50~~ 101 for a military wireless electromagnetic communications network for Back Edge of Battle Area (BEBA) operations..

128. (original) The use of a method as described in claim 1 for a wireless electromagnetic communications network for intruder detection operations.

129. (original) The use of an apparatus as described in claim ~~50~~ 101 for a wireless electromagnetic communications network for intruder detection operations.

130. (original) The use of a method as described in claim 1 for a wireless electromagnetic communications network for logistical intercommunications.

131. (original) The use of an apparatus as described in claim ~~50~~ 101 for a wireless electromagnetic communications network for logistical intercommunications.

132. (original) The use of a method as described in claim 1 in a wireless electromagnetic communications network for self-filtering spoofing signals.

133. (original) The use of an apparatus as described in claim ~~50~~ 101 for a wireless electromagnetic communications network for self-filtering spoofing signals.

134. (original) The use of a method as described in claim 1 in a wireless electromagnetic communications network for airborne relay over the horizon.

135. (original) The use of an apparatus as described in claim ~~50~~ 101 for a wireless electromagnetic communications network for airborne relay over the horizon.

136. (original) The use of a method as described in claim 1 in a wireless electromagnetic communications network for traffic control.

137. (currently amended) The use of a method as in claim ~~166~~ 1, further comprising the use thereof for air traffic control.

138. (currently amended) The use of a method as in claim ~~166~~ 1, further comprising the use thereof for ground traffic control.

139. (currently amended) The use of a method as in claim ~~166~~ 1, further comprising the use thereof for a mixture of ground and air traffic control.

140. (original) The use of an apparatus as described in claim ~~50~~ 101 for a wireless electromagnetic communications network for traffic control.

141. (currently amended) The use of an apparatus as in claim ~~170~~ 101, further comprising the use thereof for air traffic control

142. (currently amended) The use of an apparatus as in claim ~~170~~ 101, further comprising the use thereof for ground traffic control.

143. (currently amended) The use of an apparatus as in claim ~~170~~ 101, further comprising the use thereof for a mixture of ground and air traffic control.

144. (original) The use of a method as in claim 1 in a wireless electromagnetic communications network for emergency services.

145. (original) The use of an apparatus as in claim ~~50~~ 101 in a wireless electromagnetic communications network for emergency services.

146. (original) The use of a method as in claim 1 in a wireless electromagnetic communications network for shared emergency communications without interference.

147. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless electromagnetic communications network for shared emergency communications without interference.

148. (original) The use of a method as in claim 1 in a wireless electromagnetic communications network for positioning operations without interference.

149. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless electromagnetic communications network for positioning operations without interference.

150. (original) The use of a method as in claim 1 in a wireless electromagnetic communications network for high reliabilty networks requiring graceful degradation despite environmental conditions or changes..

151. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless electromagnetic communications network for high reliabilty networks requiring graceful degradation despite environmental conditions or changes..

152. (original) The use of a method as in claim 1 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion.

153. (original) The use of a method as in claim 1 in a wireless electromagnetic communications network for a secure network requiring message end-point assurance.

154. (original) The use of a method as in claim 1 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion and message end-point assurance.

155. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion.

156. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless electromagnetic communications network for a secure network requiring message end-point assurance.

157. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless electromagnetic communications network for a secure network requiring assurance against unauthorized intrusion and message end-point assurance.

158. (original) The use of a method as in claim 1 in a cellular mobile radio service.

159. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a cellular mobile radio service.

160. (original) The use of a method as in claim 1 in a personal communication service.

161. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a personal communication service.

162. (original) The use of a method as in claim 1 in a private mobile radio service.

163. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a private mobile radio service.

164. (original) The use of a method as in claim 1 in a wireless LAN.

165. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless LAN.

166. (original) The use of a method as in claim 1 in a fixed wireless access service.

167. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a fixed wireless access service.

168. (original) The use of a method as in claim 1 in a broadband wireless access service.

169. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a broadband wireless access service.

170. (original) The use of a method as in claim 1 in a municipal area network.

171. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a municipal area network.

172. (original) The use of a method as in claim 1 in a wide area network.

173. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wide area network.

174. (original) The use of a method as in claim 1 in wireless backhaul.

175. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in wireless backhaul.

176. (original) The use of a method as in claim 1 in wireless backhaul.

177. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in wireless backhaul.

178. (original) The use of a method as in claim 1 in wireless SONET.

179. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in wireless SONET.

180-181. (Cancelled)

182. (original) The use of a method as in claim 1 in wireless Telematics.

183. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in wireless Telematics.